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The use of mobility scooters by the elderly – a feasibility study in Israel

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Abstract

Studies worldwide indicate that an active lifestyle, including mobility, is essential for the quality of life of the elderly. Given the decline in elderly people's ability to serve as vehicle drivers and their physical limitations for long walks or cycling, the possibilities of using alternative transport means, e.g. mobility scooters (MS), are considered. This study aimed at exploring the feasibility of wider use of the MS by the elderly in Israel and its possible implications regarding road safety. The study included a review of knowledge worldwide on MS use by the elderly, an opinion survey of the elderly population and field observations of MS riders in urban areas. The survey was conducted using face-to-face interviews, where the questionnaire included background characteristics, health status and travel habits of the elderly, and their attitudes towards MS. The field observations were conducted by video-recording. The study found that MS are known to most elderly people in Israel, where the majority of respondents agreed that MS can improve their mobility and quality of life. However, they expressed a relatively low willingness to use MS, mostly, due to the preference for private cars but also the lack of appropriate infrastructure for MS travel in the city. Among elderly characteristics increasing the potential for MS use were: ages 70-84; people with health problems but maintaining an active lifestyle; living independently and appreciating MS benefits. The observations showed that MS users are careful in choosing travel routes, with an intuitive preference for slow traffic conditions that probably contributes to preventing accidents. Admitting an upward trend in the MS use for daily activities, appropriate infrastructure solutions for their travel are required.

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Keywords: Mobility scooters; elderly; potential use; interviews; observations

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1. Introduction

In the last decades, there is a growing attention to the special needs of the ageing population in the developed world. Research shows that the elderly are more vulnerable to road trauma than younger age groups, due to deterioration in their physical and mental abilities (OECD, 2001). At the same time, studies indicate that persuing an active lifestyle, while maintaining mobility options, is essential for preserving the quality of life of the elderly, improving their health and longevity (Whelan et al., 2006**;** Musselwhite, 2011; Levin et al., 2012). The loss of mobility due to giving-up driving among older people is considered to be one of the key catalysts for inflicting depression, increased feelings of loneliness and reduced outdoor activities (Musselwhite, 2011). Deteriorating health conditions and functional disability also often deny older age people access to other means of transport such as walking, biking or using public transport. In this regard, research conducted by Ward et al. (2013) in the UK, reported difficulties related to the use of various forms of public transport by the elderly. Given the decline in the ability of the elderly to drive motor vehicles on the one hand, and their physical limitations for long walks or cycling, on the other hand, the use of alternative transport modes are considered in various countries**.** Among those, mobility scooters (MS) were found as a suitable mode of transport for older people, particularly for those who gave up driving (Musselwhite, 2011; Blais et al., 2012; NRMA, 2012; Pullicino and Holmes, 2013). Such tools move with a relatively slow speed and are operated without physical power of the users and thus provide a reasonable alternative to traditional walking and cycling. Figure 1 provides examples of MS models, from various countries.

The Israeli Transport Regulations (TR, 2013) define a mobility scooter (MS) as a motor vehicle with three or four wheels, which is operated by electric engine (mandatory) and meets the requirements: its total width is up to 1 m; the steering is through handlebar or bar only; it is intended for one or two travelers and its maximum travel speed is up to 12 km/h. Recently, the increasing popularity of MS is being observed in urban areas, in Israel, where MS riders can be met on sidewalks, roads and junctions of city centers and residential areas. Thus, a feasibility study was initiated aiming to explore the potential of wider use of the MS by the elderly in Israel and to examine the required changes in existing urban infrastructure with regard to MS needs. The study was initiated by the research team following two empirical observations: first, an increasing appearance of MS elderly riders in many cities of the country, particularly in the vicinity of attractions, e.g. market places, shopping areas, public offices, etc.; second, road accidents involving MS riders that were found by an in-depth investigation of "bicycle" accidents reported by the police. Later on, interest in the study's findings was expressed by the Ministry of Transport.

Fig. 1. Examples of mobility scooter models, from the literature.

2. A review of international experience

Earlier surveys of the international literature (OECD, 2001; Suen and Sen, 2004; Whelan et al., 2006) recognized the potential of alternative transport means, including MS, for elderly mobility needs. As mentioned, these types of vehicles are intended mainly for short journeys in the urban environment, for the purposes of shopping, recreation, social life, or similar. Edwards and McCluskey (2010) conducted a survey of elderly MS users, in Australia, and found that MS users reported an increased sense of independence and improvement in the quality of life. Among the main obstacles for the use of MS in urban settings found in this study were environmental barriers such as difficulties in accessing curbs, uneven footpaths and grounds, hills and slopes, etc. In Canada, Steyn and Chan

(2008) found that the rate of MS use increases with older age groups of the elderly population and that most MS users stated that their limited walking ability has persuaded them to use MS. Studies conducted in the UK, Australia, Canada and Scandinavia indicated that most MS users live in urban areas, where MS serve for their daily transportation needs such as trips from their residence to shops, doctor appointments, visits to friends, etc. (Steyn and Chan, 2008; Edwards and McCluskey, 2010; Blais et al., 2012; Levin et al., 2012).

In Israel, an MS operation does not require holding a driver or a vehicle license (TR, 2013), yet a person using MS should be familiar with its operation and be in physical and mental conditions enabling him/her to operate it safely. MS driving is permitted on sidewalks or in closed areas (e.g. kibbutz), while travel on the roads is allowed only when there is no sidewalk or its size and characteristics are not suitable for MS movement. Similarly, in other countries, no license is required to drive MS (Whelan et al., 2006; Steyn and Chan, 2008). Steyn and Chan (2008) collected data on MS regulations from a number of countries such as the UK, Denmark, the Netherlands, Australia, New Zealand, Canada, and found that in most countries MS can travel on sidewalks, at relatively low speeds, whereas MS models that can reach higher speeds are required to travel on roads. According to Morris et al. (2006), in Victoria, Australia, it is permitted by law to drive MS on pedestrian paths and roads with a speed limit below 50 km/h. Litman and Blair (2012) reviewed the legal situation regarding personal mobility devices (in a broad sense, including seated MS, standing electric scooters, wheelchairs, skates, etc.) in various countries and stated that in Europe the use of such devices is typically allowed on pedestrian facilities where their maximum travel speed is below 6 km/h, but they are not permitted to travel on roads. However, in a large number of states in the USA, personal mobility devices may travel on sidewalks and on roads, where, e.g. in San Francisco, they are not permitted to travel on sidewalks. In general, the literature shows a variety of definitions and regulations with regard to MS use.

Existing urban road infrastructure arrangements are unsatisfactory for wide MS use, where available sidewalks are frequently narrow, discontinuous or uneven, constituting barriers to MS mobility (Whelan et al., 2006). Infrastructure deficiencies may include lacking ramps to move from the roadway over the curbs to the sidewalk; narrow pedestrian facilities which are unable to accommodate both MS and pedestrians; insurmountable obstacles blocking further movement on the sidewalk; street furniture and signage being placed in a way that makes progress difficult or blocks the view of approaching traffic (Whelan et al., 2006). Such deficiencies force MS users to travel on roads, thus disturbing motor vehicle traffic flow and raising safety concerns.

On the road, MS provide a limited protection for their users who are in an inferior safety position compared to other motor vehicles, particularly in traffic with high travel speeds. Edwards and McCluskey (2010) noted that MS safety is an issue of concern among MS users, authorities and public health officials. However, accident statistics involving MS users is generally lacking. Cassell and Clapperton (2006) reported on 6 deaths and 151 MS injuries needing hospitalization that were registered in five years, in Victoria, Australia. Accounting for the underreporting, they assumed that MS casualties are five times higher compared with the reported numbers. However, the majority of cases were fall accidents, while a collision with vehicles constituted 11% of MS injury cases only, indicating the presence of infrastructure problems for MS users while travelling on sidewalks and in other pedestrian areas. Among injury preventing interventions advised by various sources were MS users' training and infrastructures improvements (Morris et al., 2006; Steyn and Chan, 2008; Blais et al., 2012). The expectations on growing use of the MS among elderly people in the next decades (Musselwhite, 2011; Blais et al., 2012), strengthen the needs for adapting legislative frameworks and transport infrastructure to the MS needs.

Previous studies threw some light on the MS users' features. It was found, for example, that the average age of MS users belongs to the range of 75-81; that most users live alone (without a spouse) at private houses/apartments or protected housing, where among the main reasons for using MS they indicated health problems, particularly cardiac problems and walking inability or difficulties, and ceasing driving of motor vehicles (Brandt et al., 2004; Steyn and Chan, 2008; Edwards and McCluskey, 2010; Karmarkar et al., 2011).

3. The study's methodology

The current study was aimed at exploring the potential of MS use by the elderly population in Israel, including a characterization of potential and current MS users and an examination of infrastructure problems associated with MS use, under the local conditions. The study included two components: (1) an opinion survey aiming to assess the need and the willingness of the elderly in Israel to use MS; (2) field observations of MS riders in urban areas to identify typical MS movement patterns, their interactions with other road users and related safety problems.

3.1. Conducting the opinion survey

The opinion survey was conducted by means of face-to-face interviews with persons aged 65+, using a specially developed questionnaire. To provide content validity of the questionnaire (Carmines and Zeller, 1979), its components were developed accounting for the empirical knowledge on the subject with a particular focus on elderly needs and conditions as well as on possible factors that may influence the MS use. Therefore, the study's questionnaire included five topics (A-E) as described below:

A. Demographic data, including age, marital status, living style, economic level, education level and daily activity types of the respondents. Previous research (e.g. Steyn and Chan, 2008) indicated that demographic characteristics of the elderly may influence their desire to use MS and their attitudes about the MS need;

B. Health status and walking/cycling habits, including an examination of the participant's health conditions through a subjective judgment and objective characteristics (e.g. the frequency of visits to hospital emergency rooms, medications taken, suffering of chronic diseases). These factors may have an influence on the desire to use MS (e.g. Brandt et al., 2004; Steyn and Chan, 2008). In addition, a characteristic of participant physical conditions, according to his/her physical activities and various abilities is common in elderly research. In the current study, the physical conditions were estimated according to the respondent's ability and willingness to walk or ride a bicycle, including the ability to walk long distances, to climb stairs and to use public transportation. Similar questions were applied in a survey conducted in the UK (Thoreau, 2011);

C. Mobility habits - an examination of participant's mobility tools, including public transport use, driving a car or having mobility assistance from the family. These factors may have an impact on the intention of elderly people to use MS as an alternative transport means (e.g. Brandt et al., 2004; Steyn and Chan, 2008);

D. Attitudes about the MS use - an exploration of the participant's knowledge and opinions with regards to MS as a transportation means, conditions required for the MS use, willingness to use MS for the participant's personal needs and his/her attitudes about the advantages and disadvantages of the MS use. The latter was based on questions developed by two Australian studies (NRMA, 2012; Pullicino and Holmes, 2013);

E. Life quality - an examination of the participant's quality of life according to his/her own estimation, using a set of questions developed by Thoreau (2011). Since mobility is perceived as one of the factors that influence the quality of life, we decided to examine whether the perceived quality of life is associated with a potential to use MS.

The questionnaire consisted of 50 questions and 36 statements, of which 22 were statements about the MS use and 14 about the quality of life. Each question had a closed range of possible answers where a respondent could typically select one alternative while in some cases (everyday activities, use of transport means) multiple answers were possible. For the statements, a "1-5" scale of agreement was suggested, where "1" corresponds to absolute disagreement and "5" to high agreement with the statement.

The questionnaire was prepared in paper version and as an application of the *Qualtrics* software that was kept at the Technion website and used for remote data collection by means of electronic devices. An internal consistency of the questionnaire (Carmines and Zeller, 1979) was examined at a pilot stage, using the data of the first 24 interviews. Cronbach's alpha indices were estimated by SPSS v.20 software, for parts B, D and E of the questionnaire, where items rated on different scales were tested separately. In most cases, the values obtained were over 0.7 indicating that a reasonable level of internal consistency was obtained.

The study focused on the elderly population aged 65+ that lives in towns with more than 20,000 inhabitants. Previous studies (Steyn and Chan, 2008; Whelan et al., 2006) showed that elderly age-group and socio-economic level belong to the main factors shaping the MS use. Therefore, these two characteristics were selected to determine the strata of the survey's sample. The towns for conducting interviews were selected accounting for the sample structure as dictated by elderly population distribution among the strata defined. The interviews were carried out by students that visited elderly clubs in the selected towns.

3.2. Processing the opinion survey

Descriptive statistics of the data were produced and explanatory models were adjusted in the study. To examine the willingness of the elderly to use MS, as dependent variables in the analysis served the answers on three questions from part D: (1) "Have you ever considered a possibility of purchasing an MS?"; (2) "If you were to get a free MS,

would you use it?"; (3) "Do you think the scooter is better than a car?". We assumed that a "yes" answer to any of the questions reflects a positive opinion towards MS and a willingness to use it. Other elderly characteristics collected by the survey served as candidates for the explanatory variables in the models.

First, a univariate analysis was carried out on the data aiming to identify variables with a statistical significant impact on the willingness of elderly people to use MS. This analysis included the variables from parts A-C of the questionnaire, where for each candidate variable a cross-sectional analysis with each one of the dependent variables was conducted using a Pearson Chi-square test. A low probability value received ($p<0.05$) indicated that the explanatory variable has an impact on the dependent variable.

To examine the associations between the elderly estimates of the MS use conditions (22 statements in part D of the questionnaire) and their willingness to use MS, as well as between the perceived quality of life (14 statements in part E) and the willingness to use MS, separate analyses were conducted. In each analysis, homogeneous groups of questions were identified based on the similarity in the respondent opinions, where, further, the associations between these homogeneous groups and the willingness to use MS (the dependent variables) were examined during the adjustment of explanatory models. For grouping the questions, a factor analysis was applied (Field, 2005).

Finally, a multivariate regression model was fitted to each dependent variable. The adjusted models are binary logistic regression models (Fleiss et al, 2004) that were obtained using a Forward stepwise method, in the SPSS v.20 software. Each model estimates the probability of value "1" of the dependent variable, i.e. the intention to use MS. Due to the presence of several layers in the survey data (demographic characteristics, health conditions and walking habits, etc.), each model was adjusted in layers, when in each step of the model's development, the explanatory variables from an additional survey's layer were examined. The process of the model adjustment lasted as long as a variable adding was associated with a significant difference in the *-2Log Likelihood* parameter. In each layer, the variables most suitable for predicting the probability of MS use were selected, given the presence of variables from the previous layers. The *Hosmer and Lemeshow* test was applied to examine the quality of the model adjustment. In addition, the percentage of correct prediction and the size of the explained variance were considered, where higher values of both parameters are judged as better. The model coefficients reflect the impact of the explanatory variables on the dependent variable, where a significant impact is preferable.

3.3. Field observations

Field observations were conducted to record the MS users' behavior in the city's traffic and their interaction with other road users. Since MS appearance on the streets is not frequent, a static observation method would not be effective. Therefore, the observations were conducted dynamically, where an observer with a video-camera searched for an elderly MS rider in urban centers, during the morning hours of higher urban activities (between 9 and 13). Each MS rider observed was video-recorded during its movement on a street segment and/or a junction. Furthermore, the video-records were divided into short films of MS travel on the street segments or while crossing a junction or a crosswalk. Each film's content was coded by a unified format enabling to characterize the MS user behaviours, infrastructure and traffic conditions, and the ways of MS interactions with other road users. The collected data were analyzed aiming to identify the common MS travel patterns in the city and to recognize conflicts and dangerous situations if available.

4. Results

4.1. Descriptive characteristics of the opinion survey's sample

A total of 110 participants from 22 cities participated in the opinion survey (which took place in winter 2014). Concerning the demographic data, among the participants, 60% were females versus 40% males; 48% were aged 65-74 versus 52% aged 75+ (both splits are close to the national figures). Additional leading characteristics of the total participants were: 56% were married and 36% widowed; 65% live in their own apartments/houses, 31% - in a protected housing; 78% live independently, 10% - with a care-person. As to daily outdoor activities, 19% reported that they are not involved in any activities except for the household arrangements, where others were involved in a club or studies (52%), assisted their relatives or children (33%) or worked (23%) (multiple answers were possible).

Concerning the health conditions, 43% of the total participants defined their health status as "good", 17% as "very good"; 65% of the total did not visit a hospital in the last six month; all the participants reported on chronic diseases, where most of them (88%) take medications. With regards to walking/cycling habits, 50% reported that they are not engaged in physical activities, where 16% are engaged occasionally, and others - on a more systematical basis; 47% of the participants walk every day or a few times a week but 34% do not walk at all; most participants (93%) do not cycle at all. Among the main destinations of walking they mentioned: shopping (47%), visiting friends/relatives (43%), social activities (37%), or visiting health clinics/medical tests (37%). As to the ability to walk 800 meters, 46% answered that they do not have any difficulty, but 35% reported that they are not able to perform due to medical problems; as to the ability to climb 10 steps, 45% answered that they do not have any difficulty, but 26% - that they are unable to do so; with regard to the ability to get on/off a bus/car, 55% answered that they do not have any difficulty but 21% - that they are not able to perform.

Concerning the mobility habits, among the main transport means used by the participants, 65% mentioned a ride by relatives, 32% - driving a car, 26% - the use of public transport. Among the participants that use public transport, 90% travel alone, where 7% - with constant accompaniment by a relative or a care-person. Among all the respondents, 36% had a valid driving license, while 61% had a driving license in the past; 32% own a private car; 29% drive a car frequently.

Concerning the attitudes on the MS use, 88% of the participants were familiar with this transport means; however, only 22% ever considered the possibility of purchasing an MS, 54% would use it if they were to get it for free, 28% agreed that MS is preferable to a car. With regards to the pre-defined statements on the MS use, high agreement (an average estimate above 4, between "agree" and "strongly agree") was observed for the following statements: "the MS use helps to overcome walking difficulties", "the MS use improves the quality of life", "the MS use provides better access to various services", "the MS use in the city requires separated paths on the sidewalks or on the roads", "the MS users should pass a training before the use", "the MS use requires a sense of sight, hearing and orientation in space", "the MS use in evening hours is dangerous due to a lack of conspicuity markers", "driving MS in crowded places is difficult". Clearly, the collective opinion of elderly people actually reflects the main concerns and suggestions raised by the professional literature with regards to safer use of the MS.

4.2. Factors influencing the intention to use MS

The univariate analyses demonstrated that among the variables affecting the willingness of elderly people to use MS ($p<0.05$, with regard to at least one the dependent variables defined – see Sec.3.2) were: age group, marital status and the involvement in outdoor activities, where the age group of 70-84, single respondents and those who are more involved in outdoor daily activities were more willing to use MS. Similarly, participants that have more health problems and those experiencing more walking difficulties supported the MS use more than others. On the other hand, participants that walk frequently and those engaged in more physical activities also supported MS use more than others. Considering the mobility habits, elderly people who use other transport means versus a car, those who do not hold a driving license or did not have a driving license in the past, those who do not have a car or have a car but drive more rarely, more frequently stated that an MS is better than a car, as opposed to other respondents.

The factor analysis enabled to recognize homogeneous groups of the MS statements (from part D of the questionnaire) based on the respondent opinions. Three factors were fitted to the statements as follows: *factor 1* - "the possibilities given by MS"; *factor 2* - "requirements for MS use"; *factor 3* - "limitations to MS use". Factor 1 mostly reflects the beliefs that MS use helps to overcome walking difficulties, is recommended for people with chronic health problems, is better than driving a car, improves the quality of life, enables to shop independently, provides better accessibility to various services, enables to meet friends and family, but, at the same time, requires a good sense of sight, hearing and orientation in space. Factor 2 summarizes various requirements and conditions relevant to MS use. For example, it reflects the beliefs that MS users should undergo training before its use, that MS use should rely on an approval by a physician and on a special insurance, that MS operation involves physical and mental efforts and, also, considerable costs, and that police supervision on the MS users is lacking. Factor 3 reflects additional conditions that limit the MS use. For example, it includes the beliefs that MS use in the city requires separated paths on the sidewalks or on the roads, that MS use during evening hours is dangerous due to a lack of conspicuity markers, that MS is not suitable for use in hilly areas and that using MS in crowded places is difficult.

The factor values lie in the range of 1-5, similar to the values of statements that compose them, where each factor was given a direct meaning. For example, the more the participant appreciates the possibilities gained by the MS use, the value of factor 1 is higher; the more a participant raises the requirements for the MS use, the value of factor 2 is higher; the more the participant highlights the limitations for the MS use, the value of factor 3 is higher.

Finally, explanatory models were fitted to three dependent variables reflecting the willingness to use MS – Table 1, a-c. It can be seen that the probability that an elderly "ever considered the possibility of purchasing MS" increases with an increase in the elderly age-group, whether he/she lives in his/her own apartment/house (as opposed to other forms of living), whether he/she is more frequently engaged in physical activities and where he/she appreciates more the possibilities gained by the MS use. At the same time, this probability decreases where a person strengthens the limitations to the MS use (more supportive to the statements in *factor 3*). The probability that "an elderly would use MS, if he/she gets it for free", increases when the elderly is married (compared to other status), and, similarly to the previous model, when he/she is more frequently engaged in physical activities and when he/she appreciates more the possibilities gained by the MS use. However, this probability decreases for a working person (compared to other daily activities). The probability that an elderly believes that "MS is better than a car" increases where he/she appreciates more the possibilities provided by the MS use and decreases for a working person: all working persons in the sample answered "no" on this question, thus, creating a strong negative impact in the model.

Table 1. Binary logistic regression models fitted to the dependent variables – the intention to use MS, based on the opinion survey data
a – A probability that an elderly "ever considered a possibility of purchasing MS".

Explanatory variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for Exp(B)	
						Lower	Upper
Age	.797	.544	2.147	.143	2.220	.764	6.448
Living style: apartment/private house vs others	2.491	.812	9.404	.002	12.079	2.457	59.371
Engaged in physical activities: frequently vs rarely	1.651	.948	3.035	.082	5.214	.813	33.428
Factor 1	1.764	.598	8.710	.003	5.835	1.808	18.826
Factor 3	-1.634	.455	12.901	.000	.195	.080	.476
Constant	-6.731	2.855	5.559	.018	.001		

Models statistics: explained variance 49.2%, correct prediction 84.5%
b – A probability that an elderly "would use MS if it is given to him/her for free"

Explanatory variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for Exp(B)	
						Lower	Upper
Marital status: married vs other	1.736	.542	10.269	.001	5.677	1.963	16.418
Daily activities: work vs other	-1.549	.600	6.655	.010	.212	.065	.689
Engaged in physical activities: frequently vs rarely	1.287	.562	5.238	.022	3.622	1.203	10.902
Factor 1	.887	.342	6.737	.009	2.429	1.243	4.747
Constant	-4.986	1.518	10.793	.001	.007		

Models statistics: explained variance 31.8%, correct prediction 72.3%.
c – A probability that an elderly believes that "MS is better than a car"

Explanatory variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for Exp(B)	
						Lower	Upper
Daily activities: work* vs other	-20.045	--	.000	.998	.000	--	--
Factor 1	1.634	.463	12.475	.000	5.126	2.070	12.696
Constant	-7.499	2.033	13.605	.000	.001		

Models statistics: explained variance 41.6%, correct prediction 78.9%. * None of the working persons said "yes" and, thus, the expected probability is zero. A high negative coefficient was assigned to this characteristic.

At the same time, no model included explanatory variables concerning health conditions, the use of various transport means or keeping a driving license/using a car, by the respondents. Similarly, *factor 2* reflecting "requirements for MS use" and factors reflecting the perceived quality of life, did not appear among the characteristics associated with the intention to use MS. This implies that with regard to these characteristics the differences in the responses between the elderly people supporting and not supporting the MS use were not sufficiently strong, compared to other variables selected by the models.

4.3. MS user behaviours

A sample of 55 video-records with elderly MS riders was collected in 15 towns. In most cases (75%), it was an elderly male alone; in 9% - a female alone; in 9% - a couple of elderly male and female, where in the remainder of cases it was an elderly accompanied by a young or a care-person. Based on the video-records, two samples of short films were produced: 77 cases of MS travels on the street segments and 48 cases in which a MS was crossing a junction or a crosswalk.

First, the question of the preferred MS location - on the roadway or on sidewalk/crosswalk, i.e. behaving like a vehicle or like a pedestrian, was examined, considering the cases of MS movements on the street segments and the cases of MS crossings. Pearson Chi-square test was applied to examine the significance of differences among the types of roads, for the MS movements on the street segments, or among the types of crossing arrangements, for the MS crossing cases. We found that regardless the type of urban road (dual- or single-carriageway), in most cases (63%-68%), MS riders travelled on the roadway and not on the sidewalk, i.e. behaved *like a vehicle*. Similarly, on all types of urban junctions (signalized, un-signalized, roundabout), in most cases (56%-63%), MS riders crossed *like a vehicle*, on the road, and did not use pedestrian crosswalks. However, the way of crossing on a street segment was different where most MS riders used pedestrian crosswalks, *like pedestrians*.

Furthermore, the MS movements observed in the films were classified into four situational categories enabling to conduct a detailed examination of traffic and infrastructure conditions and the interactions between MS and other road users. They are: (1) MS travels on a street segment, on the sidewalk (28 cases); (2) MS travels on a street segment, on the road (49 cases); (3) MS crosses at junctions on the road only, like other vehicles (27 cases); (4) MS crosses on the crosswalks, like pedestrians (21 cases). Fig.2 provides examples of MS riders observed in various situations. It was found that:

- The MS travels on the sidewalks did not create conflicts with pedestrian movements, where both types of road users usually can move in one space with mutual consideration. It seems that MS riders choose to travel on a sidewalk when it is wide enough and suitable for their journey;
- The MS travels on the roads were mostly observed on streets with low traffic, where in 12% of cases only there was substantial vehicle traffic on the road. However, in 31% of the cases, the MS interrupted motor vehicles' flow and caused them to change the travel lane. Yet, only two conflicts between MS and other vehicles were observed. In addition, in 14% of the cases, MS violated traffic rules, e.g. drove against the traffic direction, overtook from the right, or drove in the left lane despite being a slow vehicle, thus, creating a risky situation on the road. In most cases of this group (96%), there was a sidewalk next to the road, while in 76% of the cases it was wide enough and suitable for MS movement. Therefore, the majority of risky situations could be avoided if the MS had traveled on the sidewalk instead of the road;
- The MS crosses on the road, at junctions, were observed on all types of junctions. Mostly, this kind of crossing occurred in low and slow traffic conditions. However, a conflict between MS and other vehicles was observed as well as the situations when MS caused other vehicles' over-taking during the junction's crossing and, hence, stimulated risky situations. In all the cases when an MS was observed as interrupting the traffic or involved in a conflict, there was a sidewalk next to the road. This means that risky situations could be avoided if the MS had traveled on the sidewalk and not on the road;
- The MS crossings on the crosswalks, like pedestrians, were generally safer than crossings on the road with other vehicles. In all the cases, no particular problems in the interaction between MS and other vehicles were observed, where vehicles usually gave a right-of-way to the MS.

Summing up the observations we can conclude that MS users choose to ride on the road, mostly, in low and slow traffic conditions that may indicate their awareness of dangers they are exposed to while traveling in mixed vehicle traffic. However, in many cases of the MS travels on the road, they interrupted other vehicles' flow and caused overtaking/lane change, therefore, endangering themselves. Typically, such cases were observed on a dual-carriageway road with a built median or at a signalized junction. In most cases, next to the road, sidewalks were available, where MS travels on the sidewalks would prevent both vehicle traffic interruptions and safety dangers. In addition, a general finding was that, under low traffic conditions, some MS users tend to disrespect traffic rules, while riding on the road in the directions and on the lanes that are convenient for them at that moment.

Fig.2. Examples of MS observed in urban areas in Israel: (a) a MS traveling on a sidewalk; (b) a MS traveling on the road, on a street segment; (c) a MS crossing a junction, on the road; (d) a MS crossing a road, on a crosswalk.

5. Conclusions

- According to the international findings (Steyn and Chan, 2008; Blais et al., 2012; Levin et al., 2012) and the situation in Israel, MS may serve as an alternative transport means for the elderly population, mostly, for short journeys in the town.
- The opinion survey showed that the elderly population in Israel is in relatively good health conditions, while managing an active lifestyle. This situation increases the need for a mobility means to carry out various tasks. Approximately half of the survey's participants claimed a certain difficulty in performing physical tasks related to walking, that may increase the potential of using MS for daily activities.
- The survey found that MS is familiar to most of the elderly people. Participants agreed that MS is suitable for a variety of uses and that it may improve their mobility and the quality of life. However, a relatively small part of the participants expressed a willingness to use MS. Among the reasons for a relatively low preference of the MS were, on the one hand, the existence of more convenient alternatives (first of all, a private car) and, on the other hand, the lack of appropriate infrastructure for MS journeys in the city and, hence, its perception as a dangerous transport means.
- Among elderly characteristics increasing the potential for MS use in Israel can be mentioned: ages 70-84; people who are aware of their health problems but still maintain an active lifestyle; living independently, and particularly those who appreciate the possibilities provided by the MS use (according to the elderly attitudes with regard to advantages and disadvantages of this transport means).

- In Israel, like in other countries, MS should travel on the sidewalks. In practice, many MS were observed on the roads, creating interruptions to vehicle flows and dangerous traffic situations. Observations showed that MS users are careful in choosing travel routes, with an intuitive preference for slow traffic conditions that probably contributes to preventing traffic accidents. However, to ensure safety of the MS users and stimulate their travels on the sidewalks, appropriate urban infrastructure adjustments are required, such as: arrangement of wide sidewalks and pedestrian paths, removal of obstacles from the sidewalks, ramp adjustments at pedestrian crosswalks (Whelan et al., 2006; Steyn and Chan, 2008; Blais et al., 2012).
- Being aware of growing population ageing and accounting for positive opinions of elderly MS users who believe that MS maintain independence following giving-up driving, an upward trend in the MS use by the elderly is anticipated in some countries, e.g. in the UK (Musselwhite, 2011) and in Canada (Steyn and Chan, 2008; Blais et al., 2012). However, the actual findings on the MS users are still scarce and more research is required with regard to their needs, including fitting infrastructure solutions for safe MS travels in all parts of the city.

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